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WWRMCM

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AERO MECH BRANCH
FLT CONTROLS LAB
EXT 29277

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EXT 30131

OXC-0567-60

18 May 1960

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MEMORANDUM FOR : Chief, Development Branch, DPD-DD/P

SUBJECT : Trip Report of Visit to Wright-Patterson Air Force Base, Ohio

1. On 12 and 13 May 1960, [redacted] visited Wright-Patterson AFB to discuss the general aspects of aeroelasticity and its influence on performance, stability, and control of high performance aircraft. Discussions were held with [redacted] of the Aeromechanical Branch and [redacted] of the Flight Dynamics Branch of the Flight Controls Laboratory. 25X1 25X1A 25X1A

2. Much work has been done toward perfecting methods of estimating the effects of aeroelasticity. By considering only the steady state conditions of flight, a method has been devised to estimate the change of performance and flight characteristics of an elastic airplane using a rigid body as the base. This method uses a rigid wind tunnel model with sufficient pressure pick-ups to accurately determine the pressure pattern over the entire surface. Once this pressure distribution is known, a modified linear line theory is used to calculate the pressure distribution over the deformed wing. Although this pressure pattern is a function of the wing distortion, it is not necessary to actually measure or calculate the magnitude of deflection. A method of mathematics using "aerodynamic operators" solves the equations of the two dependent variables simultaneously. This new pressure distribution can then be used to revise the rigid body performance estimations and to calculate the supersonic stability and control derivatives. Good correlation exists between theory and wind tunnel tests.

3. The thermoelastic effects present another set of basic problems due to the change in metal stiffness with temperature. Again theory and wind tunnel results are in fair agreement. However, the thermal transients are not included in the studies to date. Also, not enough study has been

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done as yet to estimate the effects of "creep" or "thermal fatigue." It may be necessary to replace parts and/or the entire vehicle after a given amount of time/heat usage. Although the heating is a function of Mach number, the overall problem of aero and thermal elasticity is not necessarily worst at high Mach. The lift curve slope and dynamic pressure are important variables, both decreasing at higher altitudes, where generally the higher Mach numbers are experienced. Wind tunnel studies also show that the supersonic stability derivatives do not change appreciably with Mach.

4. Estimation of the flutter characteristics under the influences of supersonic flight and thermal effects is not as well in hand as the deformation estimation of static flight. It is possible to estimate a flutter boundary when plotting dynamic pressure divided by a stiffness factor vs Mach number. The estimation of the airplane characteristics using the same parameters is not satisfactorily done. Generally, this latter estimation can be made within 10%. The aircraft labs require a safety factor of 30%, thus providing a 20% pad. However, in flutter estimations the thermal gradients, creep, thermal aging, and the change in elastic coefficients with heat must be taken into account. To date, no satisfactory method has been devised to account for these factors. The flutter determination is done through a lengthy flight test evaluation.

5. It is imperative, however, that accurate flutter investigations be made to determine the vibration nodal points in order to suitably locate the autopilot pick-ups. Unfortunately, these nodal points shift with Mach number, thus greatly complicating the autopilot installation. Consideration is now being given to locating a series of pick-ups at the individual nodal points and programming the autopilot to receive information as a function of Mach. No opinion would be expressed on the recommendation of linear vs adaptive autopilots.

6. A short visit was also made to the B-70 project office. Very little aeroelastic information is available at this time. Although a major wind tunnel effort is scheduled, very little of the program has been done. The only conclusive test accomplished so far determined that the mathematical estimation of the elastic effects on the rudder was conservative. Hence, a redesign to provide additional directional stability was necessary. This redesign will probably result in increased aerodynamic drag, increased weight, and increased system complexity.

7. The many laboratories and facilities at Wright-Patterson enjoy the enviable position of being a collection agency of the latest information on the research programs of all types. In addition, much basic research and applied techniques testing is being done "in house." It is strongly recommended that the contractors on the programs establish suitable liaison with these labs (possibly through [redacted]'s office for cover, if necessary) and maintain a working relationship there in order to take full advantage of the vast amount of knowledge that is available for the asking.

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4 - DB/DPD
5 - RI/DPD

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